C. 6720

MAY, 1933

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

RECEIVED
JUN 16 1933
O. S. U. LIBRARY

VERMICULITE

BY

A. V. PETAR

I.C. 6720
ay, 1933.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

VERMICULITE[1]

By Alice V. Petar[2]

FOREWORD

Although known to mineralogists for many years, vermiculite was of little r no commercial value prior to 1925. It was described in the American Journal f Science in 1824 by T. H. Webb, who named it vermiculite from the Latin ermiculari, to breed worms, because of its property of expanding and unfolding nto worm-like forms when heated. It is said that in Japan it was a popular musement to throw vermiculite on hot coals to see it exfoliate.

The commercial development of vermiculite has been largely due to the fforts of one company, "The Zonolite Co.," of Libby, Montana, which controls arge deposits of raw material and has developed diversified markets for its roduct. Vermiculite is already an important ingredient of many insulating aterials and other articles of commerce, and interest in the material among oth producers and consumers is evidently growing.

DESCRIPTION AND PROPERTIES

The term "vermiculite" is applied to a group of micaceous minerals that enerally are alteration products of biotite, phlogopite, and other varieties f mica. The original cleavage is partly retained; other physical properties nd the chemical composition show varying degrees of alteration. The most ronounced characteristic of vermiculites is their extraordinary expansion on eating; the volume may increase up to 16 times the original. Some varieties ontain as much as 20 per cent of water and the expansion occurs as the water s given off. This expansion or exfoliation takes place in only one direction, right angles to the cleavage. At the same time the color changes from lack or dark brown to a silvery or golden hue, according to the degree of eat and the exposure to the air. This change of color is believed to be due the oxidation of the iron, and it may be controlled to a limited extent by cluding air during heating. In an atmosphere of diminished oxygen content e oxidation is incomplete and the color decreased in intensity. The specific

---

The Bureau of Mines will welcome reprinting of this article, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6720."

Rare metals and nonmetals division, U. S. Bureau of Mines.

gravity of the raw material is in the neighborhood of 2.5, whereas after heating, the expanded mass has been reported to have an apparent gravity as low as 0.087. The untreated material weighs about 100 pounds per cubic foot; after heat-treatment the average product varies in weight from 6 to 20 pounds per cubic foot.

Under the heading "Vermiculites" Dana lists a number of minerals, the best known of which are vermiculite and jefferisite. Other varieties are kerrite, lucasite, lennilite, hallite, painterite, philadelphite, protovermiculite, vaalite, maconite, dudleyite, pyrosclerite and roseite. These minerals show great similarity and in most instances the names are derived from the localities in which specimens have been found.

USES

Largely as a result of research and sales promotion on the part of the principal producer of vermiculite, many uses have been developed. Vermiculite is of little or no value in its raw state, and the following applications relate to the treated material. Its value in heat and cold insulation has been demonstrated and it is an effective sound insulator. Vermiculite has been recommended as an insulating material in fireless cookers, incubators, ovens, pipe and boiler coverings, and refrigerators. When used to fill hollow spaces over ceilings it is said to make houses warmer in winter and cooler in summer. It has been used as an insulator in safes and filing cabinets with apparent success. As a sound deadener it is of particular value in moving picture studios and apartment houses. Mixed in a plaster with wood pulp, vermiculite is said to have been tried out on the walls of Canadian theaters for its acoustic properties with satisfactory results. It is, of course, fireproof.

Vermiculate is used as a fine aggregate in place of sand in connection with gypsum plaster for interior plastering purposes. The cost of such walls is said to be about 5 cents per sq. yd. greater than when ordinary sand is used, but the weight is considerably less and the walls have good insulation properties.[3] In experimental work performed at the University of Kentucky, Lexington, C. S. Crouse[4] reports that a plaster composed of 30% plaster of Paris, 60% calcined vermiculite, and 10% asbestos was not disintegrated when placed in a red-hot furnace. Fireproof insulating board made from vermiculit is said to stand exposure to 1700° F. without any appreciable expansion or contraction.[5]

The golden color of treated vermiculite is utilized in making gold paint The material may also be used as a paint pigment or kalsomine by tinting to t desired color. Vermiculite is also used as a decorative material in wallpape

---

[3] Rock Products. Progress in the Use of Zonolite. Vol. 35, April 23, 1932, pp. 17-18.

[4] Crouse, C. S. Calcined vermiculite as a plaster base. Eng. and Min. Jou vol. 128, No. 24, Dec. 14, 1929, pp. 923-924.

[5] Rock Products. Colorado Vermiculite - Its Discovery and Development. Vol. 35, Aug. 13, 1932, pp. 22-24.

With asphalt binders or tar adhesives vermiculite has been used as a mposition roofing. A product marketed as Zonoasphalt is described as a re-proof roofing material, guaranteed for 20 years without painting or pairing.

The lubricating qualities of vermiculite are said to be comparable to ose of flake graphite. It has the property of coagulating or hardening ls so that it may be used instead of aluminum stearate, and at the same me serve as a valuable lubricant. When so used the bearing surfaces be- me coated with the soft flaky material and friction is reduced to a mini- m. For this use the vermiculite should be water ground to about minus 0 mesh.[6]

Insulating cements made from Colorado vermiculite are on the market. ey are claimed to have a covering capacity as high as 60 sq. ft. per 100 lb. t and no volume or linear shrinkage when dried; the dry weight per cu. ft. place will not exceed 20 lb.

Vermiculite is also used in an insulating brick which is said to have a ushing strength of 175 - 200 lb. per sq. in. and a density of 22.5 lb. per . ft. The brick will stand constant exposure of 1850 deg. F. without preciable shrinking or checking.[7]

Other products in which vermiculite is used to advantage are automobile fflers and high temperature gaskets.

MODE OF OCCURRENCE[8]

Vermiculite is a constituent of some altered igneous rocks and it general- occurs mixed with other minerals and thus distributed through the rock mass. a few places, however, it is found in almost clean or unmixed bodies large ough to mine. Bodies that have a dikelike form and range from 1 to 6 feet width are reported from North Carolina.

DOMESTIC DEPOSITS

Montana

The largest known deposits of vermiculite are in the lower part of the sin of Rainy Creek, about 7 miles northeast of Libby, Montana. The area is

---

Rock Products. Progress in the Use of Zonolite. Vol. 35, April 23, 1932, pp. 17-18.

Rock Products. Colorado Vermiculite - Its Discovery and Development. Vol. 35, Aug. 13, 1932, pp. 22-24.

Pardee, J. T. and Larsen, E. S. Deposits of Vermiculite and Other Minerals in the Rainy Creek District near Libby, Montana. U. S. Geol. Surv. Bull. 805-B, 1929, pp. 22-23.

accessible to the main automobile highway along the north bank of the Kootenai River and is within a few miles of the Great Northern Railway. This occurrence is described by Pardee and Larsen,[9] as follows:

> "A body of vermiculite in the Rainy Creek district that is being developed by the Zonolite Co. on the spur north of Kearney Creek is much larger than any deposit heretofore known. It presents no natural exposures, but its outcrop and the slopes below are mantled with a yielding slippery soil composed chiefly of mica-like flakes. As incompletely shown by the workings so far made, this body appears to be of dikelike form and at least 100 feet wide, and 1,000 feet long. It extends to a depth of more than 100 feet, its lower limit not being shown. Several smaller bodies of vermiculite occur in the ground of the Vermiculite & Asbestos Co. on the northwest slope of the same spur. There a tunnel penetrates six bodies that range from 1 to 4 feet in width. They are of flat lenslike or tabular form, and most of them are definitely separated from the wall rock by fault or slip planes. Incomplete exposures of several other similar bodies are made by smaller workings. * * * Samples representing areas of several square feet at different places in the workings of the Vermiculite & Asbestos Co. contained from 30 to 84 per cent of vermiculite. Apparently there is a huge amount of such mixed material."

The property now operated by the Zonolite Co. was accidentally discovered in the Spring of 1916 by E. N. Alley, when he was prospecting for other minerals. While examining a quartz stringer in an old tunnel he noted that the heat from the candle which he had stuck in the wall had caused a leaf of mineral to swell. He took some of the material home and on heating it on the stove and in the fire found that it did not burn but swelled to many times its original size and turned a gold color. It resembled gold nuggets but was light as a feather, which caused it to be known for some time as "feather gold."[10] It was soon apparent that there was an abundant supply of material that possessed remarkable properties, but no use was known for it. Mr. Alley glimpsed the commercial possibilities of vermiculite and, after several years of experimentation, joined with other interested parties to organize the Zonolite Co. at Libby, Montana, to exploit the deposits. The company developed a heat-treated vermiculite which it markets under the trade name "Zonolite," and for which it has found many actual and potential uses. Commercial production was undertaken on a small scale in 1925. In 1931, the Dominion Stucco Co. Ltd., of St. Boniface, Manitoba, a subsidiary of Gypsum, Lime and Alabastine, Canada, Ltd., acquired an interest in the company, and has subsequently promoted the sale of zonolite in Canada.

---

[9] Pardee, J. T. and Larsen, E. S. Deposits of vermiculite and other minerals in the Rainy Creek District near Libby, Montana. U. S. Geol. Surv. Bull. 805-B, 1929, pp. 23-24.

[10] Pit and Quarry. Quarrying and Refining Zonolite. May 23, 1928, p. 82.

As freight rates on crude vermiculite are lower than on the expanded aterial, the Zonolite Co. finds it advantageous to ship the crude material, re-screened to the proper size and pre-dried of surface moisture, from the ine to points of consumption. The Zonolite Products Co., an affiliated mpany operates expansion units at Joliet, Illinois and Brooklyn, N. Y., d distributes zonolite throughout the territory east of the Mississippi; e Western territory is handled by the Zonolite Sales Co.

The Vermiculite & Asbestos Co. was organized early in 1927 to exploit eposits near Libby, Montana, and for a time the Micalite Co. operated several laims in the same region.

According to the U. S. Geological Survey, the following occurrences in ntana have not been described in published reports: Sec. 19, T. 28, N., . 16 E., in the Rocky Boy Indian Reservation, Hill County, owned by the earpaw Mining and Milling Co., Havre, Montana, and about 12 miles east of milton, at the head of Gird Creek in the Sapphire Mountains, Ravalli County, ned by S. H. Chamberlain, Victor, Mont.

Colorado

Half a dozen promising occurrences of vermiculite have been reported in lorado. Alderson[11] refers to three, as follows:

> "The first discovery of jefferisite in commercial quantity was made by W. B. Thomas in 1913, in the Turrett mining district, 14 miles north of Salida, Colo. The deposit occurred as a vein, 20 inches in width, in a granite formation. About 8 carloads were mined and shipped, but on account of the high cost of mining, the venture was unsuccessful. Later another deposit, 9 miles from Iola, Gunnison County, was discovered. * * * W. B. Thomas and others, in October 1923, visited the main Colorado deposit. The jefferisite is found 7 miles from Westcliffe, the county seat of Custer Co., an old and well known mining district. The company has a tract of 80 acres on which the jefferisite is well exposed in seven places. * * * On an adjoining tract of 60 acres, under lease by the Jefferisite Products Co., are 5 openings, 2 shafts 10 and 12 ft. deep, and 3 open cuts, all of which show jefferisite."

The deposits at Turrett and at Westcliffe were operated in 1929.

Vermiculite has been mined by the Denver Mining & Manufacturing Co. from deposit about 5 miles southeast of Hecla, and the heat-treated product sold der the name "Tung Ash." J. M. Kyrl, of Chicago, operated the Goldenite d Silverite mine in Fremont County, Colo., near Hillside, in 1931, and

---

[1] Alderson, Victor C. Jefferisite. Colo. School of Mines, Circ. of Inf., undated, 4 pp.

development work was reported at several other vermiculite properties during 1932. Non-Metallics, Inc., started to develop a vermiculite deposit about 9 miles west of Rye, Colo., owned by E. F. Gobatti, of Pueblo,[12] and a deposit at Feldspar was worked by L. D. Christison, who also owns a deposit of lower grade material near Cotopaxi. Colorado vermiculite is treated by the George B. Smith Chemical Works, Inc., of Springfield, Ill., and manufactured into insulating bricks and blocks, sectional pipe covering, insulating cements, etc. It is reported that Gustavus Sessinghaus, of Denver, shipped several tons of vermiculite in 1932 from a deposit 8 miles from Buena Vista, Colo.

North Carolina

The presence of vermiculite in North Carolina has been known for many years, but until recently there has been little or no commercial production. The variety known as Culsageeite was reported upon in 1873 by Cooke,[13] and Ross and Shannon[14] have described an occurrence of nickeliferous vermiculite about one mile east of Webster, N. C. Within recent months there has apparently been a growing interest in the development of vermiculite deposits in the State, and shipments have been made by at least one producer.

Pennsylvania

The variety of vermiculite known as Jefferisite was discovered many years ago in a serpentine quarry near West Chester, Penna., by William W. Jefferis, for whom it was named. The deposit, known locally as the Brinton Quarry, was worked in 1929 by the John Warren Watson Co., of Philadelphia.

Wyoming

A deposit of vermiculite near Encampment, Wyoming, is being developed by the Parco Development Co.; it is reported that the company shipped 44 tons of the material from its property in 1931.

Other States

Occurrences of vermiculite have been encountered elsewhere in the United States, but commercial developments appear to be limited to the above-mentione localities.

---

[12] Mining Journal (Arizona) Vol. 16, No. 5, July 30, 1932, p. 20.

[13] Cooke, Josiah P., Jr. Culsageeite, the Vermiculite of the Jenks Mine, North Carolina. Am. Acad. Arts and Sci., Proc., vol. 9, 1873, pp. 48-5

[14] Ross, Clarence S. and Shannon, Earl V. Nickeliferous Vermiculite and Serpentine from Webster, North Carolina. Am. Mineralog., vol. 11, No. 4, April, 1926, pp. 90-93.

MINING AND TREATMENT

The methods of mining and treating vermiculite employed by the Zonolite). are described as follows:[15]

"At the present time the property is being worked from the top as an open quarry. The overburden, which varies from 10-in. to 2 ft., is scraped off and a face of pure zonolite about 30 ft. wide and 150 ft. long constitutes the present working pit. Engineers estimate that the deposit contains at least 25,000,000 tons of the mineral. * * *

"On account of the transportation problem it soon became apparent that the raw mineral would have to be shipped to industrial centers and expanded near the place of use. In 1925 the Zonolite Co. built a large plant at Libby to expand the mineral and the plant is still in existence but the modern trend is toward shipping the raw rock. This would call for a large number of plants throughout the east which, obviously, for the tonnage available per plant, had its disadvantage. So here again the problem is being met in a novel manner.

"The idea was to develop a small 'expander' which would be leased on a royalty basis. The machine would represent a small investment and its capacity would be in the neighborhood of two tons of zonolite per hour. In working out the design of such a device it was found that heat alone was not all that was necessary to secure a maximum expansion of the mineral. In the rotary type kiln the best expanded material weighed 7 to 9 lb. per cu. ft. on the ½-in. material. On the new type expander, a description of which follows, the mineral has been expanded to weigh as low as 5 lb. per cu. ft. Material of this weight is so light that the direct flame from an oil or gas burner literally blows it out of the furnace. * * *

"In using the gas or electrically heated machine it was found advantageous to size the crude zonolite before expanding it. This is done by using a "Jigger" vibrating screen that gives three sizes of zonolite: ½-in., 1/8 in. and fines. These are expanded separately and almost instantly.

"The furnace consists of a machine which is also known as a "Jigger." A vibrating plate 3 ft. wide and 7 ft. long and set at a slight slope is enclosed in a firebrick housing hung independent of the plate. When gas is used as fuel the heat is applied above the vibrating plate through suitable port holes and where electricity is used the electric heating elements are hung about 5 in. above the plate. The sized raw zonolite is fed to the top of the vibrating

---

) Rock Products. Progress in the Use of Zonolite. Vol. 35, No. 8, April 23, 1932, pp. 17-18.

Original from THE OHIO STATE UNIVERSITY

plate and as it descends is thrown up into the heated zone and this results in a uniformly expanded material at low cost. The machine has a capacity of 4000 lb. per hour and requires a 3-hp. motor to operate the vibrating mechanism. The electric heating elements are rated at 45 kw. and use 220 volt, 3-phase alternating current. They will withstand a temperature of 1800 deg. F. The machine and process are protected by patents and it is proposed to lease the machine on a royalty basis."

FREIGHT RATES

Because of its light weight and consequent bulk, expanded vermiculite carries a high freight rate ($65.00 per ton on shipments from Libby, Montana to Eastern points, in less than carload quantities), which makes it impracticable to ship the material between distant points. To meet this situation the Zonolite Co. has adopted the plan outlined on page 7. The company ships the crude ore, pre-screened to the proper size, and pre-dried of surface moisture, from the mine to points of consumption. Freight rates on vermiculite in this form are as follows: To the Chicago district, $10.00 per ton; to Pittsburgh, Cleveland, etc., $12.00; and to the Eastern Seaboard, $15.00 per ton.

The following freight rates, supplied by the Interstate Commerce Commission, governing various forms of mica, apparently apply to vermiculite:

Crude vermiculite 1/ Carloads, min. wt. 80,000 lb. (cents per 100 lb.)		Ground vermiculite 2/ (cents per 100 lb.)		
From:	Libby, Mont.	Libby, Mont.	Denver, Colo.	Asheville, N.
To:				
Chicago, Ill.	50	50	75	997 3/
Joliet, Ill.	50	50	75	997 3/
St. Louis, Mo.	60	60	75	900 3/
Boston, Mass.	75	85	--	850 3/
New York, N. Y.	75	85	--	750 3/
Philadelphia, Pa.	75	85	--	630 3/

1/ Classified as "crude hydrated biotite mica."

2/ Classified as "ground mica."

3/ Cents per 2000 pounds.

PRICES

Little information is available with reference to prices of vermiculite. In September, 1932, the Zonolite Products Co. (a unit of F. E. Schundler & Co., Brooklyn, N. Y., and largest distributor of the output of the Zonolite Co.) quoted pre-dried and screened vermiculite at $15.00 per ton, f.o.b. Libby, Montana, in bulk. The expanded material is sold from the company's expanding plant at Joliet, Illinois at $45 per ton on sizes which do not require particular grinding. In March 1933, quotations for vermiculite appeared in Metal and Mineral Markets, the figure being $7 per ton, f.o.b. mines, North Carolina.

POSSIBLE PRODUCERS

L. S. Rees, Western Rawlplug, Inc., 1156 California St., Denver, Colo.
Zonolite Co., Libby, Montana.
Bearpaw Mining & Milling Co., Havre, Mont.
S. H. Chamberlain, Victor, Mont.
Manganiferous Iron Co., 500 Minnesota Bldg., St. Paul, Minn.
J. K. Chalmers, 632, H. W. Hellman Bldg., Los Angeles, Calif.
R. E. Tilden, 2829 Benvenue Ave., Berkeley, Calif.
H. O. Aaberg, Myers Hotel, Janesville, Wisconsin.
Parco Development Co., Encampment, Wyoming.
D. E. C. Austin, Turret, Colo.
Joseph W. Kryl, Westcliffe, Custer Co., Colo.
Vermiculite & Asbestos Co., Libby, Mont.
John Warren Watson Co., West Chester, Penna.
Philip S. Hoyt, Industrial Minerals Corp., Franklin, N. C.
R. G. Rogers, Boice Hardwood Co., Inc., Hayesville, N. C.
S. A. Jones, Waynesville, North Carolina.
Norman S. Poole, Hayesville, North Carolina.
Roland W. Ainsworth, Hillside, Ariz.
J. M. Kyrl, 1526 W. 22nd St., Chicago, Ill.
Gustavus Sessinghaus, Engineers Bldg., Denver, Colo.
E. F. Gobatti, Pueblo, Colo.

POSSIBLE BUYERS

K. L. Conley, Vancouver Plywood Co., 333 N. Michigan Ave., Chicago, Ill.
L. B. Miller, Research Chemist, Johns-Manville Research Laboratories, Materials Development Section I, Manville, N. J.
F. E. Schundler, 45th St. & 1st Ave., Brooklyn, N. Y.
John A. Wiener, 81 W. 7th St., Oswego, N. Y.
Morgenstern Asbestos Covering Co., 3951 Utah Street, St. Louis, Mo.
George R. Hall & Sons, 11 E. 44th Street, New York, N. Y.

BIBLIOGRAPHY

Alderson, Victor C. Jefferisite. Circular of Information, Colo. School of Mines, undated, 4 pp.

Asbestos. The many uses of zonolite. Vol. 10, No. 2, Aug., 1928, pp. 16-18.

Canadian Chemistry & Metallurgy. "Zonolite," a new industrial mineral. vol. 14, No. 10, Oct., 1930, p. 36.

Cement, Mill & Quarry. Many uses found for zonolite. April 5, 1926, pp. 30-32.

Cooke, Josiah P. Jr. Culsageeite, the vermiculite of the Jenks mine, North Carolina. Am. Acad. Arts & Sci., Proc., vol. 9, 1873, pp. 48-59.

Crouse, C. S. Calcined vermiculite as plaster base. Eng. Min. Jour., vol. 128, 1929, pp. 923-924.

Pardee, J. T. and Larsen, E. S. Deposits of vermiculite and other minerals in the Rainy Creek District near Libby, Montana. U. S. Geol. Surv. Bull. 805-B, 1929, pp. 17-29.

Pit and Quarry. Quarrying and Refining Zonolite. May 23, 1928, p. 82.

Rock Products. Zonolite, a new light-weight insulator. June 26, 1926, pp. 63-64.

____________. Colorado vermiculite — its discovery and development. vol. 35, Aug. 13, 1932, pp. 22-24.

____________. Progress in the use of zonolite, vol. 35, April 23, 1932, pp. 17-19.

____________. Annual Report of the Zonolite Co., Vol. 35, No. 20, Oct. 8, 1932, p. 35.

Ross, Clarence S. and Shannon, Earl V. Nickeliferous vermiculite and serpentine from Webster, North Carolina, vol. 11, No. 4, April, 1926, pp. 90-93.

Ross, Clarence S., Shannon, Earl V., and Gonyer, Forest A. The origin of nickel silicates at Webster, N. C. Econ. Geol., vol. 23, 1928, pp. 528-552.

Shannon, E. V. Vermiculite from the Bare Hills near Baltimore, Md. Am. Jour. Sci., vol. 15, 1928, pp. 20-24.